

WHAT IS CLAIMED IS:

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1. A motorized focusing device, said device comprising:  
a housing, said housing having a distal end and a proximal end and comprising (i) a substantially straight bore having a distal end and a proximal end, (ii) first attaching means at said distal end of said housing for mechanically attaching said housing to an image capturing device, (iii) second attaching means at said proximal end of said housing for mechanically attaching said housing to an image receiving apparatus, (iv) a cavity in said housing, said cavity having a first end disposed substantially adjacent to said side wall of said bore, and (v) an opening connecting said bore and said first end of said cavity;  
a tubular lens carrier having a distal end and a proximal end, said lens carrier (i) having an outer surface that is characterized by a longitudinally-aligned series of rack gear teeth, an open distal end, and an open proximal end, (ii) containing at least one coaxially mounted focusing lens and (iii) being slidably disposed in said bore for selective movement between a proximal-most position and a distal-most position;  
a motor assembly mounted in said cavity, said motor assembly including a reversible powered drive device having an output shaft;  
gear means connecting said output shaft to said series of rack gear teeth for selectively moving said lens carrier between its proximal-most and its distal-most positions in said bore in response to rotation of said output shaft by said drive device;  
whereby an image captured by said image capturing device and relayed by said at least one focusing lens may be focused on an image receiving device by movement of said lens carrier.

2. A motorized focusing device according to claim 1 further comprising biasing means for urging said tubular lens carrier toward one of the ends of said bore.
3. A motorized focusing device according to claim 2 wherein said biasing means comprises a coil spring disposed in said bore between a stop adjacent one of the ends thereof and said tubular lens carrier.
4. A motorized focusing device according to claim 1 further including windows closing off said open ends of said lens carrier.
5. A motorized focusing device according to claim 1 wherein said gear means comprise a worm gear axially attached to said free end of said drive shaft such that at least a portion of said worm gear extends through said opening and the teeth of said worm gear mesh with said rack gear teeth on the outer surface of said lens carrier.
6. The motorized focusing device according to claim 5 wherein said lens carrier has a longitudinal axis, and said drive shaft extends parallel to said longitudinal axis.
7. The motorized focusing device according to claim 5 wherein said worm gear is a conical spiral gear, said lens carrier has a longitudinal axis, and said drive shaft is disposed at an acute angle to said first longitudinal axis.

8. A motorized focusing device according to claim 1 wherein said opening comprises a second bore that communicates with said first-mentioned bore and said cavity, and said gear means comprise a worm gear attached to said free end of said drive shaft, and a helical pinion gear rotatably disposed in said second bore, with the teeth of said helical pinion gear in meshing engagement with the teeth of said worm gear and said rack gear teeth.

9. A motorized focusing device according to claim 1 wherein the lead angles of all the teeth of said gear means are substantially equal to one another.

10. A motorized focusing device according to claim 1 wherein the lead angle of said gear teeth is about 3.5 degrees.

11. A focusing device, said device comprising:  
a housing;

said housing having (i) a distal end and a proximal end, (ii) a substantially straight bore extending between said distal and proximal ends, (iii) first means at said distal end of said housing for mechanically attaching said housing to an image-capturing device, and (iv) second means at said proximal end of said housing for mechanically attaching said housing to an image-receiving apparatus;

a lens transport assembly comprising a hollow lens carrier having a distal end, a proximal end and at least one focusing lens secured coaxially therein, said lens transport assembly being disposed within and

sized so as to be in a close-fitting sliding relation with said bore, said lens transport assembly being slidable bidirectionally in said bore toward and away from said first and second windows; and

electromechanical means mounted to said housing and coupled to said lens transport assembly for moving said lens transport assembly bidirectionally in said bore, so as to adjust the focusing of an image passed by said at least one focusing lens.

12. A focusing device according to claim 11 further including a spring disposed in said bore so as to urge said lens transport assembly toward a predetermined one of said windows.

13. A focusing device according to claim 11 wherein said housing comprises a first internal stop adjacent said distal end of said bore, and said spring is disposed between said first stop and the adjacent end of ~~said lens transport assembly.~~

14. A focusing device according to claim 13 wherein said housing further comprises a second internal stop adjacent said proximal end of said bore for limiting movement of said lens transport assembly toward said proximal end of said housing.

15. A focusing device according to claim 11 further including an optical image-capturing device attached to said first means.

16. A focusing device according to claim 15 wherein said image-capturing device is an endoscope.

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17. A focusing device according to claim 11 further including an image-receiving apparatus attached to said second connecting means.

18. A focusing device according to claim 17 wherein said image-receiving apparatus is a video camera.

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19. A focusing device according to claim 11 wherein said housing includes first and second transparent windows closing off the distal and proximal ends of said bore respectively.

20. An image viewing and focusing system, said system comprising in combination:

(a) an image capturing device;

(b) a video camera;

(c) an electromechanically operable focusing coupler device interposed between and connecting said image capturing device and said camera, said coupler device providing an optical path for transmitting images from said image capturing device to said camera, said coupler device comprising:

a housing, a lens transport assembly movably disposed in said housing, and electromechanical means mounted to said housing for moving said lens transport assembly bidirectionally in said housing;

said housing having a distal end and a proximal end, and an internal surface defining a substantially straight bore extending between said distal end and said proximal end;

said lens transport assembly having a lens carrier containing at least one focusing lens, said lens carrier having a cross-sectional size and shape such that it makes a close sliding fit in said bore; and

said electromechanical means comprising a reversible electric motor and gear means coupling said motor and said lens transport assembly for moving said lens transport assembly in said bore according to the direction of operation of said reversible electric motor.

21. The system according to claim 20 wherein said motor and said gear means are contained within said housing.

22. The system according to claim 20 wherein said motor is contained in a motor housing attached to said first-mentioned housing.

23. The system according to claim 20 further including switch means for selectively controlling forward and reverse operation of said motor..

24. The system according to claim 23 wherein said switch means comprises a foot-operated switch.

25. A focusing coupler for coupling an endoscope with a video camera, said coupler comprising:

a lens unit comprising at least one focusing lens and a lens carrier supporting said at least one lens;

a housing having a cylindrical bore in which said lens unit is slidably disposed for reciprocal movement axially of said bore, said housing including two windows closing off the opposite ends of said bore,

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whereby to permit light to enter one end of said bore, pass through said at least one focusing lens, and exit the opposite end of said bore; and  
motor controlled mechanical means for moving said lens unit bidirectionally in said bore between said windows so as to adjust the focus of light passing through said lens.

26. A pneumatically operable focusing device comprising:

(1) a housing having first and second opposite ends and a cylindrical inner surface defining a straight bore that extends between first and second opposite ends, said bore having first and second ends corresponding in relative position to said first and second ends of said housing;

(2) a lens transport assembly comprising a hollow cylindrical lens carrier and at least one focusing lens mounted to said carrier in coaxial relation therewith, said carrier being disposed within and in close fitting relation with said bore so as to be slidable axially in said bore;

(3) a first stop means in said bore adjacent said first end thereof;

(4) a compression spring mounted within said bore between said stop means and said lens transport assembly, said spring acting to urge said lens transport assembly to move toward said second end of said bore;

(5) a second stop means in said bore adjacent said second end thereof for limiting movement of said lens transport assembly away from said first end of said bore;

(6) first and second transparent means closing off the opposite ends of said bore;

(7) a cavity in said housing communicating with said bore between the ends thereof;

(8) gear means coupled with said lens transport assembly via said cavity; and

(9) a reversible electric motor having its output shaft connected to said gear means, whereby rotation of said output shaft due to energization of said motor will cause said lens transport assembly to move forward or backward in said bore according to the direction of rotation of said output shaft, with movement of said lens transport assembly resulting in adjustment of the focus of images passed by said at least one focusing lens.

27. A device according to claim 26 further including an endoscope attached to said first connecting means and an electronic camera attached to said second connecting means.

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